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ABSTRACT

This report explores some of the critical issues that have emerged from the data collected from the Third International Mathematics and Science Study-Repeat (TIMSS-R) to inform educational decisions in the state of Delaware. Research questions include Delaware's student performance on the TIMSS-R and the Delaware Student Testing Program (DSTP), Delaware students' lives and their classroom experience, and Delaware mathematics and science teachers and their practice in the classroom. The data illustrate multiple facets of the educational system including classroom environment, instructional practice, students' activities out of school time, teachers' beliefs about learning, professional development opportunities, homework assignments, and curriculum. Results show that students in other states consistently outperform Delaware students across content strands and items in both mathematics and science. Students in Delaware reported frequent classroom interruptions in their mathematics and science lessons. The majority of Delaware students are not taught mathematics and science by teachers who have majored in mathematics, science, or math/science education. This report includes several examples of TIMSS-R problems together with statistical data. (KHR)

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TIMSS-R 1999: AN ANALYSIS OF THE DELAWARE SCIENCE COALITION DATA

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29 MAY 2001

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INTRODUCTION

Overview of TIMSS-R Study

The Third International Mathematics and Science Study (TIMSS) was conducted in 1995 and was the most comprehensive international study of student performance and schools ever conducted examining fourth, eighth, and twelfth grades. Classroom video data were also collected in Germany, Japan, and the United States. The TIMSS-R conducted in 1999 collected only data for eighth grade students and their schools. This provides longitudinal data for the students in fourth grade in 1995 and eighth grade in 1999. In addition to student performance data in mathematics and science, the study also collected survey data from the students, teachers, and administrators, to provide a context for students' performance. The survey questions addressed issues ranging from curriculum content and instructional practice to beliefs about learning and issues of school climate.

The Delaware Science Coalition

The TIMSS-R participants included 38 countries, 13 States, and 14 districts and consortia, including the Delaware Science Coalition. The Delaware Science Coalition (DSC) is a coalition of 15 school districts working in partnership with the Delaware Department of Education and the business-based advocate for quality education, the Delaware Foundation for Science and Mathematics Education. The mission of the DSC is to improve the teaching and learning of science for all students grades K-8. The Coalition includes approximately 2,200 teachers who serve more than 90 percent of Delaware's public school students. Sampling for the TIMSS-R study assessed 1,359 students in 25 middle schools from the Coalition and represent 17% of the eighth graders in the State. The Delaware Science Coalition will be referred to as "Delaware" throughout this report.

Purpose

Delaware participated in the TIMSS-R to provide baseline data for mathematics and science middle school learning in the States. After the TIMSS-R administration the National Science Foundation funded two local systemic change initiatives in the summer of 1999 in both mathematics and science. The TIMSS-R data were collected in the spring of 1999 providing an opportunity to assess the status of Delaware classrooms and students' performance prior to reform based initiatives.

The TIMSS-R also provides an international context for Delaware's performance. The data allow comparisons with other coalitions, consortia, states, and countries. As mentioned above the data include assessments as well as survey data about the school and district contexts that inform the assessment results and provide some guidance for improvement. In addition to an international benchmark, TIMSS-R also provides the tools for Delaware educators to assess the locally developed

curriculum standards, frameworks, and the State assessment in reference to other States and consortia that outperformed Delaware.

Figure 1 is a timeline that provides a context to frame the conversation about the Delaware results from the TIMSS-R administered in 1999. The TIMSS-R data were collected during the same year the Mathematics and Science initiatives were begun at the Middle School Level. The data provide a snapshot of Delaware education prior to the reform movement.

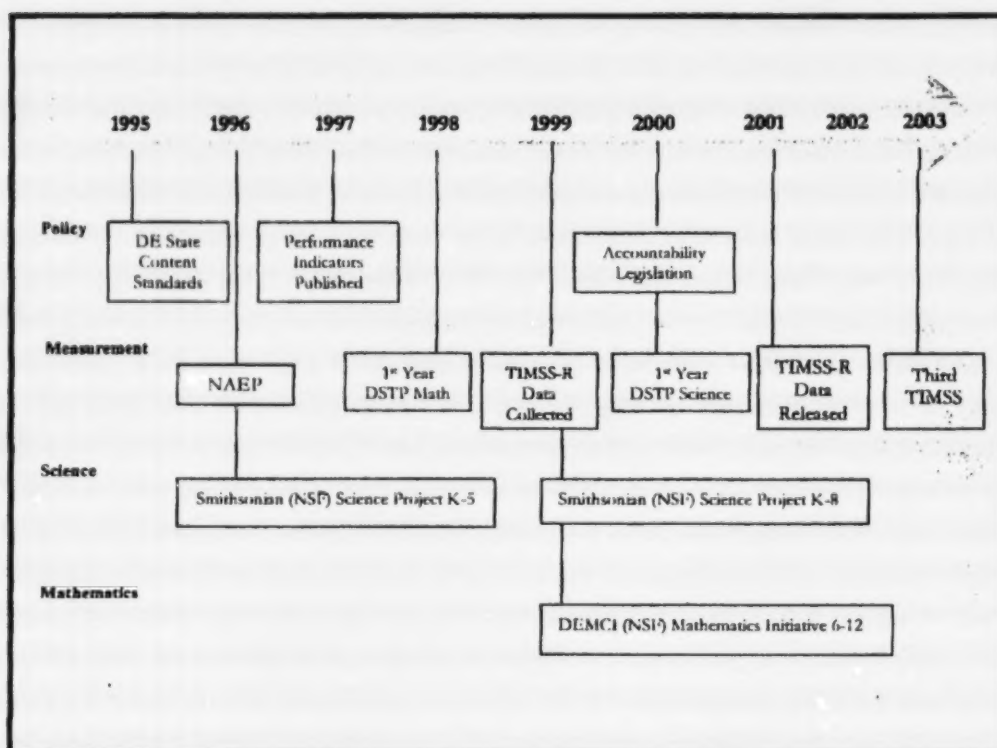


Figure 1: Delaware Timeline

The TIMSS administration in 2003 will provide longitudinal data about the changes in instructional practices, learning resources, and other factors influencing student learning. It is important to keep in mind while reading through these results that this is baseline data for the reform in Delaware and is not an assessment of the current educational initiatives underway in the State.

OVERVIEW

Contents

There is much to be learned from a data source this comprehensive. This report provides the data analysis completed with a grant from the Delaware Foundation for Science and Mathematics Education. Six research questions were explored and are presented following this introduction in three sections. Each section will include the following.

- ☒ Findings from the TIMSS-R for Delaware
- ☒ Comparisons with a subset of States and Consortia
- ☒ Discussion of the findings
- ☒ Suggested questions for discussion

This study investigates only a few of the critical issues but a data set of this proportion requires more exploration and investigation. This report is not a comprehensive analysis of all the data important for Delaware, but the following six research questions were examined and are grouped into three major areas of interest.

☐ Delaware Student Performance

1. How does Delaware's student performance compare with other various States and consortia in mathematics and science, in the specific content strands, and on individual assessment items?
2. How is student performance on the TIMSS-R related to performance on the DSTP across students' ethnicity?

☐ Delaware Students' Lives and the Classroom

4. How do Delaware students' beliefs about their education and out of class activities compare with other States and consortia?
5. How do Delaware students describe their classroom experience?

☐ Delaware Teachers' Classroom Practice

5. How do Delaware teachers compare with other States and consortia?
6. How do teachers and students describe what goes on in their classroom?

Each research question is discussed separately and this report concludes with a final discussion of all findings.

Recommendations for Use of this Report

The purpose of this report is to tease out some of the critical issues that have emerged from the voluminous data collected from the TIMSS-R study to inform educational decisions in the State of Delaware. The data illustrate multiple facets of the educational system including classroom environment, instructional practice, students' out of school time, teachers' beliefs about learning, professional development opportunities, homework assignments, curriculum, and so forth. The TIMSS-R data have implications for teachers, administrators, students, parents, policy makers, curriculum specialists, school counselors, and educational researchers. It is recommended that this report be reviewed by teams of school personnel to support a conversation about data driven decision-making and the future direction of education in the State.

(1) DELAWARE STUDENT PERFORMANCE

Comparison of State & Consortia Performance

1. How does Delaware's student performance compare with other various States and consortia in mathematics and science, in the specific content strands, and on individual items?

Overall Performance Results

Delaware performed at the National and International averages in both mathematics and science (See Figure 2). Although there are some differences in the scores within each content area they are not statistically significant.

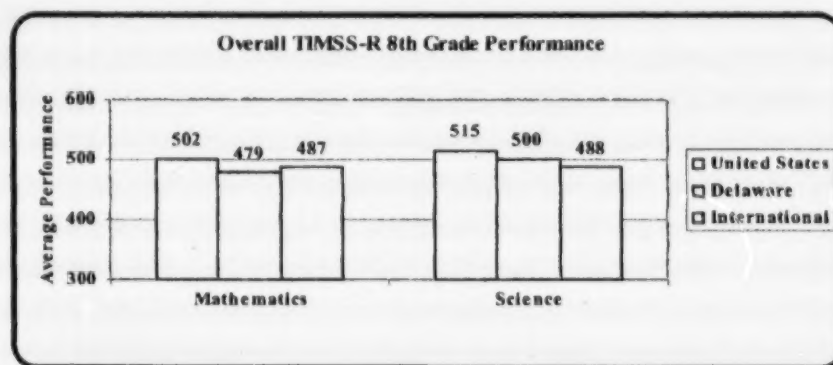


Figure 2: Comparison of Average Performances of U.S., DSC, and International.

The overall average performance for Delaware in mathematics and science is telling but not intensely informative. The more informative data are found by examining individual States and consortia.

Six other States and consortia were chosen from the sample to use for comparison purposes. These regions were chosen based on four criteria: (1) demographic compatibility, (2) use of reform curricula, (3) regional proximity to Delaware, and (4) student performance. A brief profile of the States and Consortia included in this report are in Table 1 followed by a description of each of the consortia. The descriptions were provided by the respective consortia and are verbatim from the TIMSS-R Benchmarking Reports (2001).

State/ Consortia	% Minority	# Assessed	Math Avg	Science Avg
DE Science Coalition	37	1268	479	500
Maryland	45	3317	495	506
Michigan	18	2623	517	544
North Carolina	38	3097	495	508
First in the World	26	750	560	565
SMART	21	1096	521	539
SW Math/Science Collaborative PA	13	1538	517	543

Table 1: Summary of States and Consortia Chosen for this Report

First in the World Consortium

The First in the World Consortium consists of a group of 18 districts from the North Shore of Chicago that have joined forces to bring a world-class education to the region's students and to improve mathematics and science achievement in their schools. Resulting from meetings of district superintendents in 1995, the consortium decided to focus on three main goals: benchmarking their performance to educational standards through participating in the original TIMSS in 1995 and again in 1999; creating a forum to share the vision with businesses and the community of benchmarking to world-class standards; and establishing a network of learning communities of teachers, researchers, parents, and community members to conduct the work needed to achieve their goal.

Project SMART Consortium

SMART (Science & Mathematics Achievement Required for Tomorrow) is a consortium of 30 diverse school districts in northeast Ohio committed to continuous improvement, long-term systemic change, and improved student learning in science and mathematics in grades K-12. It is jointly funded by the Ohio Department of Education and the Martha Holden Jennings Foundation. The schools that participated in the project represent 17 of the 30 districts.

Southwest Pennsylvania Math and Science Collaborative

The Southwest Pennsylvania Math and Science Collaborative, established in 1994, coordinates efforts and focuses resources on strengthening math and science education in the entire southwest Pennsylvania workforce region that has Pittsburgh as its center. Committed to gathering and using good information that can help prepare its students to be productive citizens, the Collaborative is composed of all 118 "local control" public districts, as well as the parochial and private schools in the

nine-county region. Several of these districts are working together in selecting exemplary materials, developing curriculum frameworks, and building sustained professional development strategies to strengthen math and science instruction.

Performance Across Content Areas

Mathematics performance data are displayed in Figure 3 and illustrate the performance differences across Delaware and the three States and three consortia in mathematics. The Delaware Science Coalition is outperformed by all other entities referenced. The State of Michigan in particular performed well in both mathematics and science. North Carolina maintains very similar demographics with 38% minority compared to Delaware's 37% and produced significantly higher scores in mathematics than Delaware.

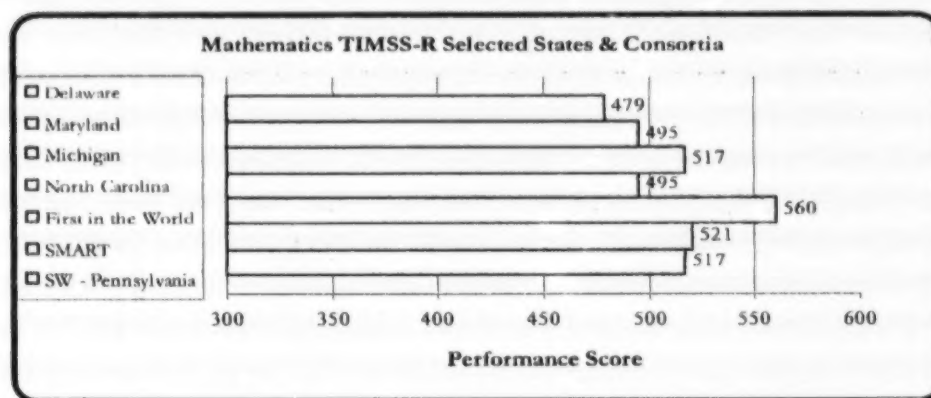


Figure 3: Mathematics Performance

Science performance across these regions is displayed below in Figure 4. The SW-Pennsylvania collaborative did particularly well in their science performance while North Carolina and Maryland did not perform as well in reference to their peers in science. The SMART group also did well in both mathematics and science as did First in the World.

Including the various consortia provide a comparison with other small regions and groups of schools or districts that have similar goals as the Delaware Science Coalition. This study will discuss some of the differences across these regions that might contribute to their students' relatively high rates of success in mathematics and science.

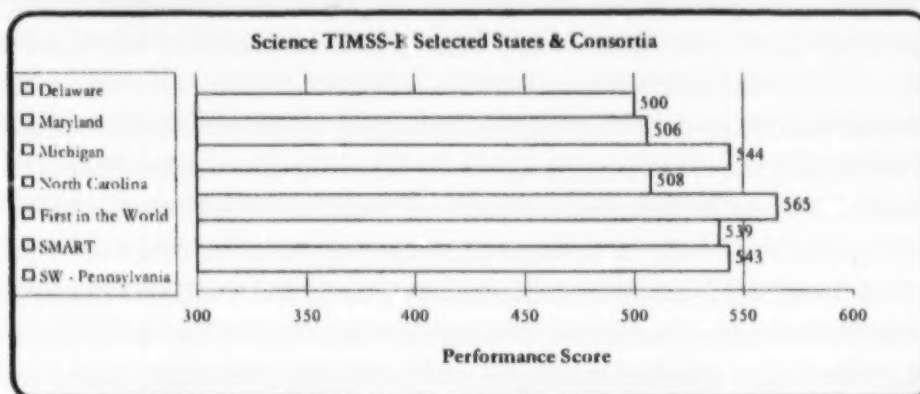


Figure 4: Science Performance

Performance Across Content Strands

To better understand the regions that outperformed Delaware it is useful to examine the individual content strands within the mathematics and science content areas to determine Delaware's strengths and weaknesses in reference to the TIMSS-R items. The TIMSS-R items might or might not be aligned with the Delaware Standards. There are currently two other studies under way to examine the TIMSS-R alignment in both mathematics and science to the Delaware Standards. However, regardless of the degree of alignment, the examination of the individual strands allows a comparison with other States who have *also* developed their own standards and whose curriculum also might or might not be aligned with the TIMSS-R assessment. The TIMSS-R assessment is not designed to align with any one particular set of standards but is intended to provide a global comparison across content areas.

Figure 5 illustrates the differences across consortia and States in the specific content strands. Delaware students are weakest in Measurement and Geometry and are performing their best in Algebra and Data Representation. Michigan, First in the World, and SMART students are performing well in Fractions and Number Sense, Data Representation, and Algebra. Geometry is the most challenging area for all seven regions.

The TIMSS-R data cannot provide a simple answer or one key to improve classroom instruction but can illuminate some patterns across high performing States and consortia that might contribute to increased student performance. Emphasis on students' understanding of mathematical concepts is one example of an approach that was not stressed in Delaware classrooms in 1999. All the other States and consortia in this report expressed a "Major Emphasis" on "Understanding

Mathematics Concepts" while Delaware reported a "Moderate Emphasis." Michigan, First in the World and Maryland also report a "Major Emphasis" on "Solving Non-Routine Problems."

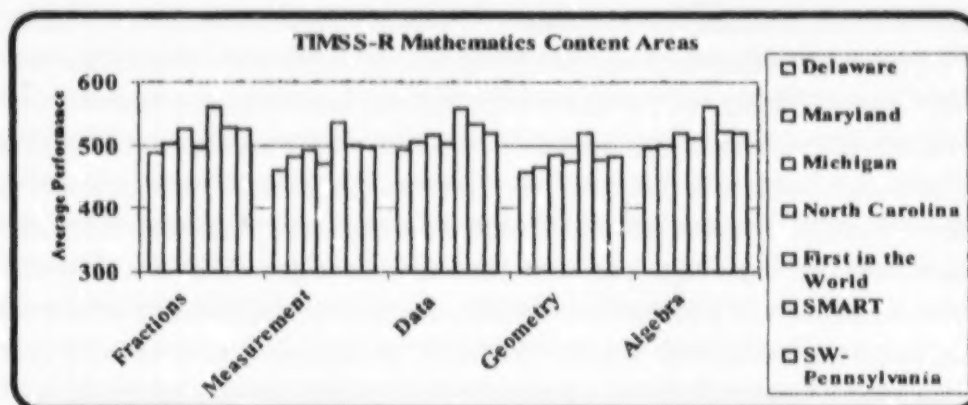


Figure 5: Performance at Content Strands

The science content strands also provide information about the overall higher performing States and consortia. Delaware students performed their best in both Earth Science and Life Science and higher or equivalent to Maryland and North Carolina (See Figure 6). However, (a) Physics, (b) Environmental and Resource Issues, and (c) Scientific Inquiry and the Nature of Science posed more of a challenge for Delaware's students.

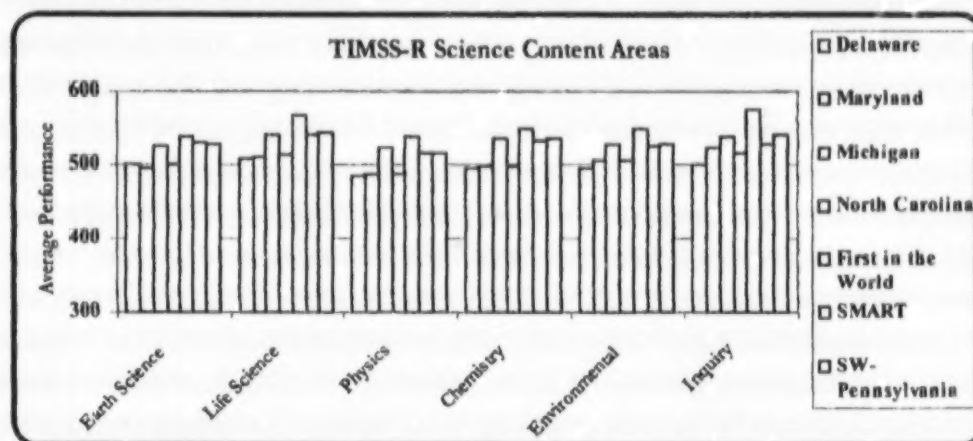


Figure 6: Performance at Content Strands

Michigan students performed extremely well in science, equivalent to the students in Singapore, Japan, and the Netherlands. Michigan reported a "Major Emphasis: on the following approaches and processes in their science classrooms:

- ☐ Understanding science concepts
- ☐ Applying science concepts to solve problems and develop explanations
- ☐ Performing experiments
- ☐ Designing and conducting scientific investigations
- ☐ Science, technology, and society

Delaware teachers reported a similar emphasis in their classroom with respect to approaches and processes, but also reported 31% and 68% of class time emphasized general science and earth science respectively, whereas Michigan devoted 32% of their time to Physical Science. This example demonstrates a difference in the curriculum and content covered in each State and helps inform the differences in performance. However, given that Delaware students are spending the majority of their time learning about Earth Science a higher performance score might be expected in that area. Although Delaware students performed their best in the area of Earth Science, the Delaware students did *not* significantly outperform any other State in that content strand.

Performance Across Selected Items

This section highlights a handful of the TIMSS-R items to illustrate Delaware students' strengths and weaknesses in responding to the mathematics and science performance items. The Delaware students' performance on each item will be compared to the students' performance in other regions. This type of comparison brings to front the performance differences between Delaware and other higher performing areas, highlighting the fact that other States are outperforming Delaware consistently across content strands. The critical message is not that Delaware was outperformed, but that there is much to be learned from these other States and consortia about how they support their students' learning in the various content strands. The TIMSS-R example item numbers used are consistent with the numbers in the TIMSS-R Benchmarking Reports (2001).

Mathematics Assessment Items

In mathematics, Delaware students' performance was weakest in the areas of Measurement and Geometry. The TIMSS-R Example Item 7 displayed in the box below illustrates a Measurement item that 76% of the students tested in Delaware did *not* solve correctly. Student performance across the States and Consortia for this particular item is displayed in Figure 7. Delaware is outperformed by all entities on this item. This question was an upper quartile TIMSS-R benchmark item.

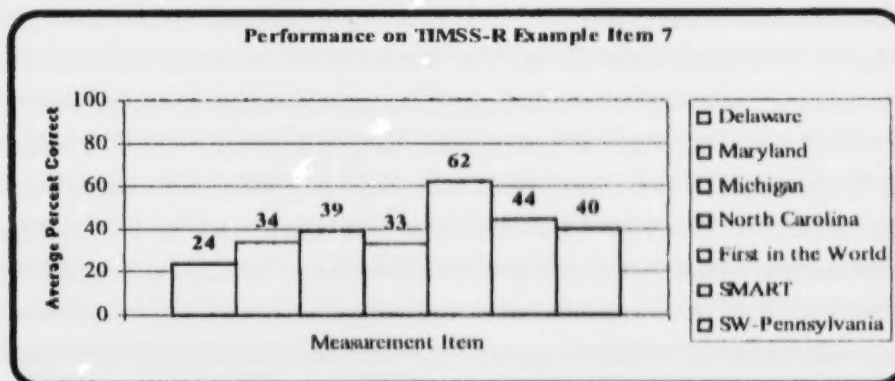
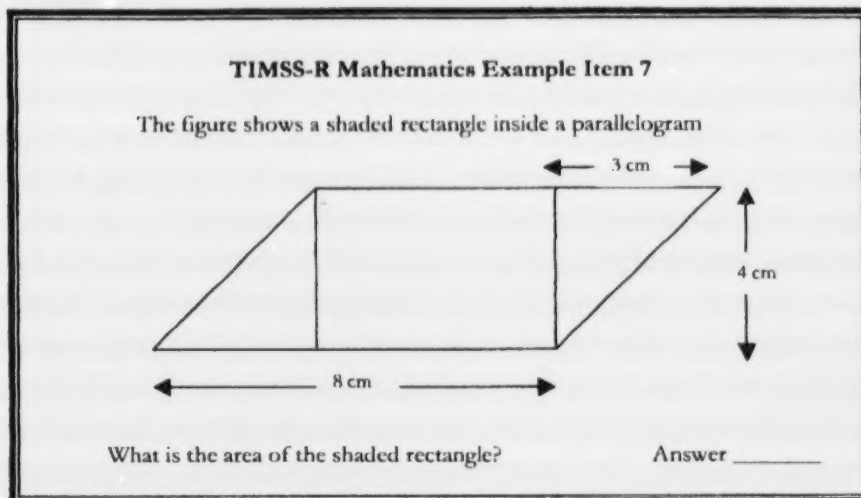


Figure 7: Performance on TIMSS-R Mathematics Item 7

A second mathematics item that illustrates differences across States and Consortia is a median TIMSS-R International benchmark item from the Algebra strand displayed in the box below. Student performance on this item is displayed in Figure 8. Delaware students performed similar to students in Maryland and North Carolina, which is representative of these three States' overall performance in the Algebra content strand. Students in Michigan (82% Correct) performed significantly higher than the students in Delaware and were the highest performing State for this item.

TIMSS-R Mathematics Example Item 12

n is a number. When n is multiplied by 7, and 6 is then added, the result is 41.

Which of these equations represents this relation?

- A. $7n + 6 = 41$
- B. $7n - 6 = 41$
- C. $7n \times 6 = 41$
- D. $7(n + 6) = 41$

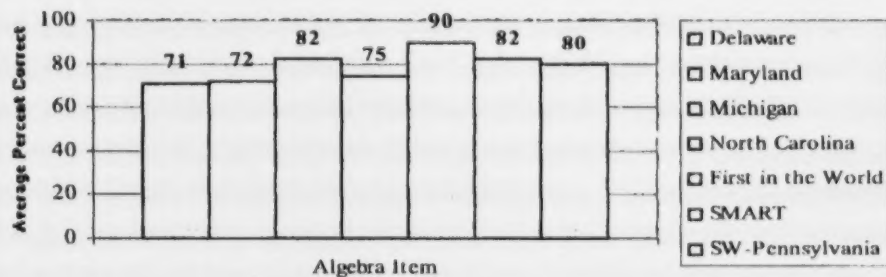
Performance on TIMSS-R Example Item 12

Figure 8: Performance on TIMSS-R Mathematics Item 12

The third and final mathematics item reviewed is from the Fractions and Number Sense strand. This is an upper quartile TIMSS-R International benchmark item and is a multi-step word problem displayed in the box below.

TIMSS-R Mathematics Example Item 6

John sold 60 magazines and Mark sold 80 magazines. The magazines were all sold for the same price. The total amount received for the magazines was \$700.

How much did Mark receive?

Answer: _____

Again, Delaware students performed similar to students in Maryland and North Carolina, while Michigan students scored well above these three States (See Figure 9). Students in Delaware also performed similar to the students of the SMART Consortium in Ohio and other States in the TIMSS-R study including Connecticut, Idaho, and Missouri. Performance within the United States on this item ranged from 55% correct for students in the First in the World Consortium to 18% correct in Miami-Dade P.S., Florida.

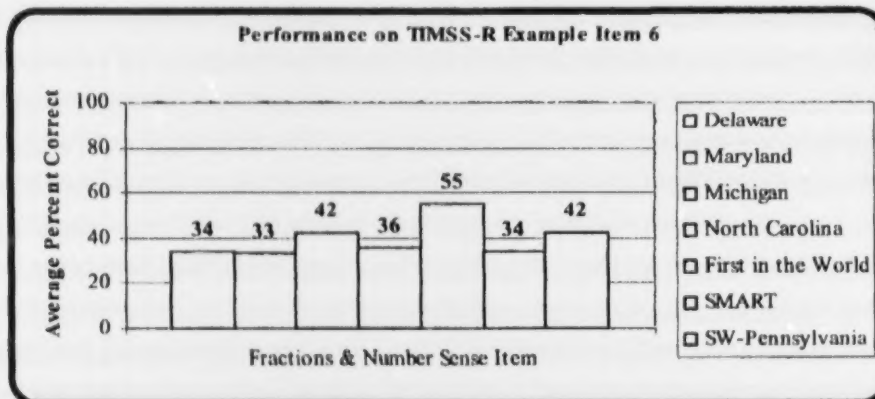


Figure 9: Performance on TIMSS-R Mathematics Item 6

Science Assessment Items

Delaware students had the most difficulty in the science areas of Chemistry, Environmental and Resource Issues, and Physics. A TIMSS-R chemistry item 15 is displayed in the box below, and is a median international benchmark item. 40% of Delaware students did **not** answer this item correctly.

TIMSS-R Science Example Item 15

Paint applied to an iron surface prevents the iron from rusting. Which ONE of the following provides the best reason?

- A. It prevents nitrogen from coming in contact with the iron.
- B. It reacts chemically with the iron.
- C. It prevents carbon dioxide from coming in contact with the iron.
- D. It makes the surface of the iron smoother.
- E. It prevents oxygen and moisture from coming in contact with the iron.

Student performance is displayed in Figure 10. Analogous to performance on some of the mathematics items, Delaware students performed similar to students in Maryland and North Carolina, yet again Michigan has outperformed each of these States.

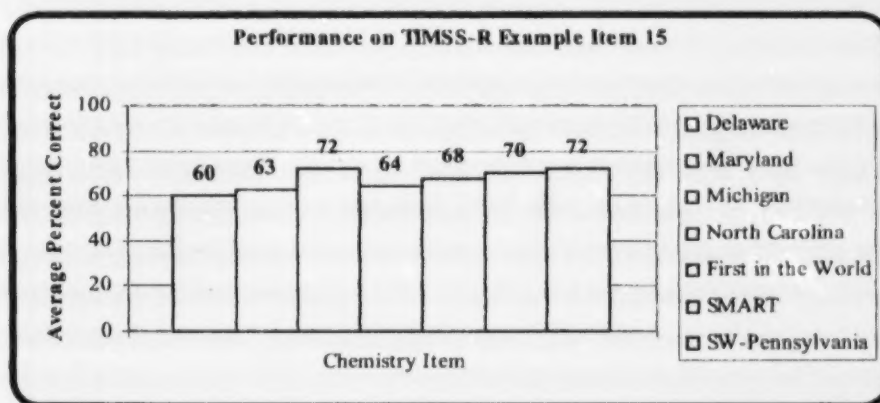


Figure 10: Performance on TIMSS-R Science Item 15

The next science item reviewed is from the Environmental and Resource Issues strand. It is also a median TIMSS-R International benchmark item and is displayed in the box below.

TIMSS-R Science Example Item 16

Rain and running water can wash away soil.
From which is soil most likely to be washed away?

- A. A sloping flat area with bushes
- B. A flat area with grasses
- C. A flat area that is barren
- D. A sloping area that is barren

Performance within the United States on this item ranged from 85% percent of the students answering correctly in the Academy School District, Colorado to 44% correct in Miami-Dade County PS, Florida. Student performances for the entities highlighted in this study are exhibited in Figure 11.

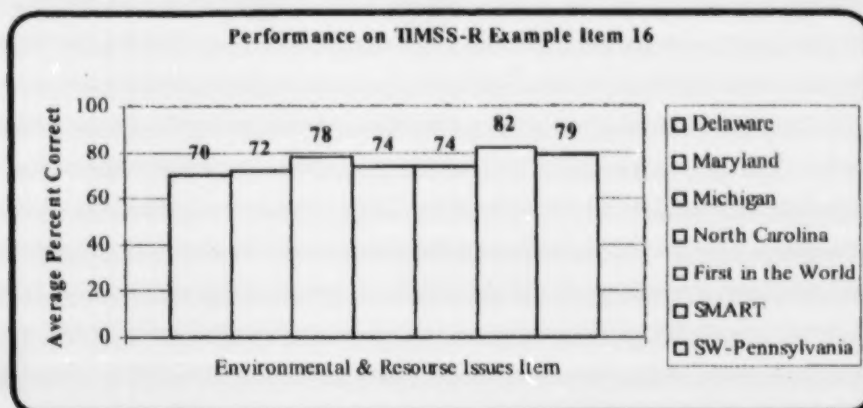
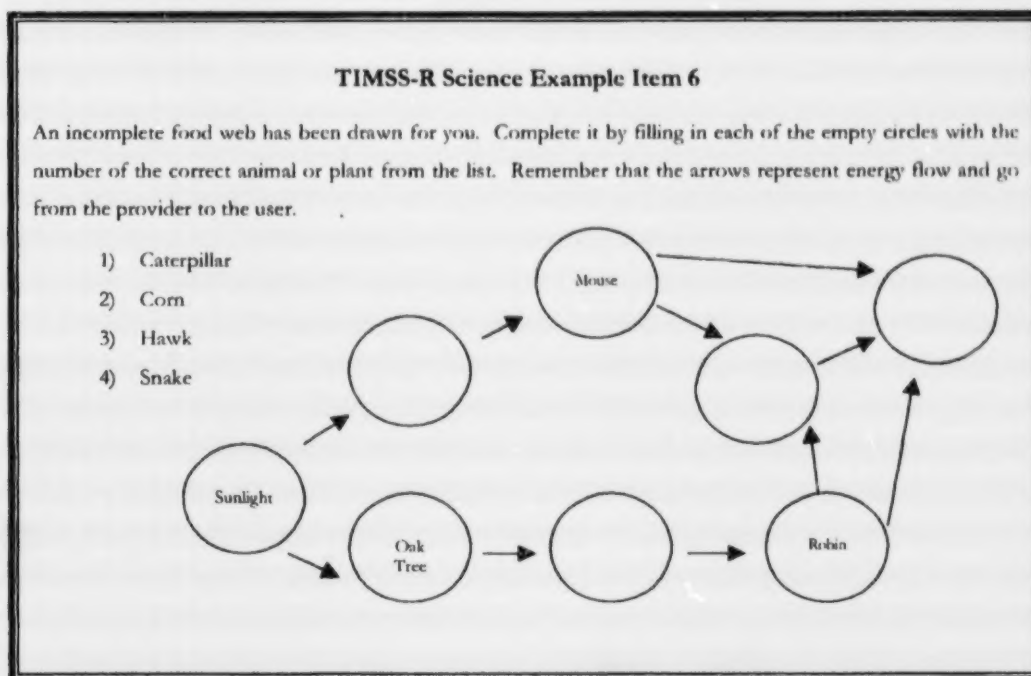


Figure 11: Performance on TIMSS-R Science Item 16

The final science item included in this report is from the Life Sciences strand and is an upper quartile TIMSS-R International benchmark item. The students in Delaware performed their best in the Life Sciences strand compared to the other science strands.



Performance in the United States on this item ranged from 84% correct in the Academy District, Colorado to 31% correct in Miami-Dade County, Florida. In addition there was a wide range of performance across the States, with 70% of the Michigan students answering correctly and only 44% answering correctly in North Carolina (See Figure 12). As mentioned above student performance

might be related to the mathematics and science curricula implemented in each States and Consortia, however Michigan's students are performing well across **all** content areas in **both** mathematics and science regardless of the alignment between the curriculum used and the TIMSS-R assessment.

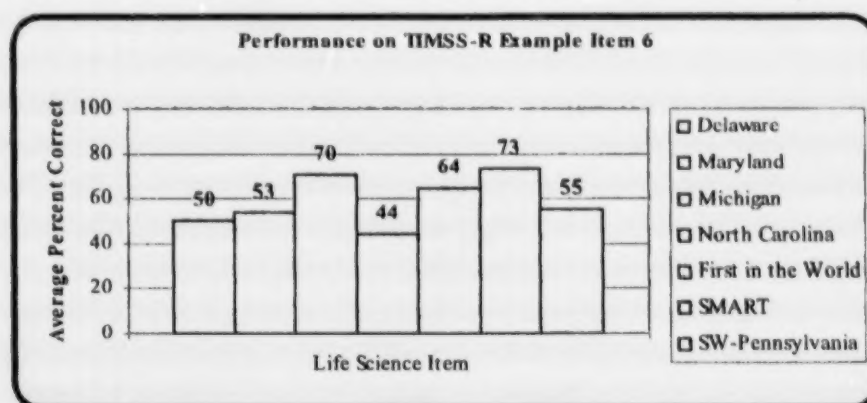


Figure 12: Performance on TIMSS-R Science Item 6

Summary

The review of mathematics and science items from different content strands provides an overview of the types of questions the TIMSS-R assessment includes. In summary research question 1 reports the following:

- ☑ Students in other States consistently outperform Delaware students across content strands and items in both mathematics and science.
- ☑ There are particular strands that are more challenging for Delaware students. For example, Fractions and Number Sense, Measurement, and Geometry pose the most difficulty in mathematics, and Chemistry, Environmental and Resource Issues, and Physics in science.
- ☑ It might be argued that the Delaware mathematics and science curricula were not intended to address particular topics in 1999 and/or do not plan to address certain strands until high school coursework. However, other States are consistently outperforming Delaware across all content strands including those that are stressed in the local Delaware Standards.

Questions for discussion about curriculum and student performance might be:

- (1) Should other content strands be emphasized in the classroom and/or curriculum to better prepare Delaware students in an International market?
- (2) Are the content areas that were most challenging for Delaware students being addressed in the reform-minded curricula currently supported in the State? If not, is that satisfactory?
- (3) How might Delaware students' performance change over time given the systemic reform initiatives underway?
- (4) Could Delaware expect improvement in their students' performance in a future TIMSS administration? If so, will it be expected in certain content strands?

These are all difficult and challenging questions that are raised by participating in an international assessment but discussions about these data and the current state of education in the State will benefit from thoughtful conversations among educators and policy makers about these critical issues of curriculum and learning.

(2) DELAWARE STUDENT PERFORMANCE

TIMSS-R and DSTP Comparison

2. How is student performance on the TIMSS-R related to the DSTP across students' ethnicity?

Please note the term "Black" is used to describe African-Americans. Because this was an International study involving students from many other countries including Africa, TIMSS chose to use the descriptors, Black, White, and Hispanic and these terms will be used for purposes of consistency.

Mathematics

The first figure displays students' TIMSS-R Mathematics performance across ethnicity. There is an achievement gap between ethnic groups across all four States (See Figure 13).

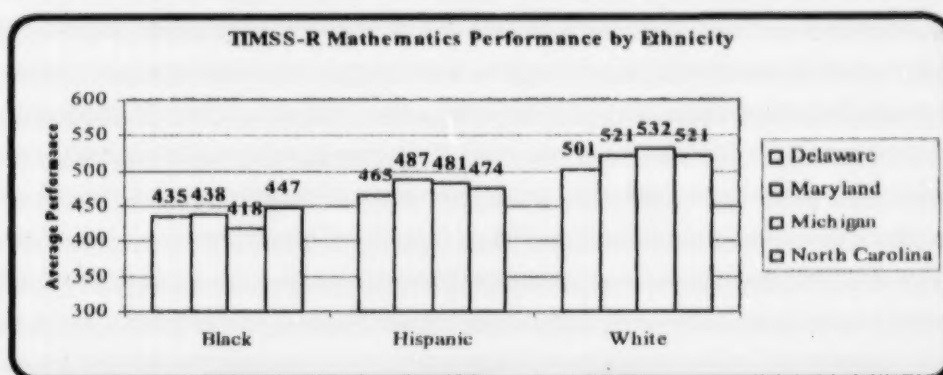


Figure 13: Average Mathematics Performance Across Ethnic Groups

The White students in Delaware are **not** performing as well as their counterparts in other States, but the achievement gap between ethnic groups is smaller in the State of Delaware than in the other States used in this report (See Table 2). For example, the Black and Hispanic students in Michigan are performing **well** below the White students in Michigan.

State	Delaware	Maryland	Michigan	North Carolina
Performance Difference	66	83	114	74
Percent Difference of 800 Points	9%	10%	14%	9%

Table 2: TIMSS-R Mathematics Achievement Gap Across Black and White Student Performance

The student performance across ethnic groups on the Mathematics (1999) Delaware Student Testing Program (DSTP) also displays a gap between the White and Non-White students. The scores are scaled differently on the TIMSS-R and the DSTP making a direct comparison difficult. However, a few comparisons are meaningful and others will be explored more fully as more TIMSS-R data become available. The first mathematics DSTP figure displays the average student performance scores across ethnicity (See Figure 14). There is a 31-point difference between the average Standards Based Score between White and African-American students.

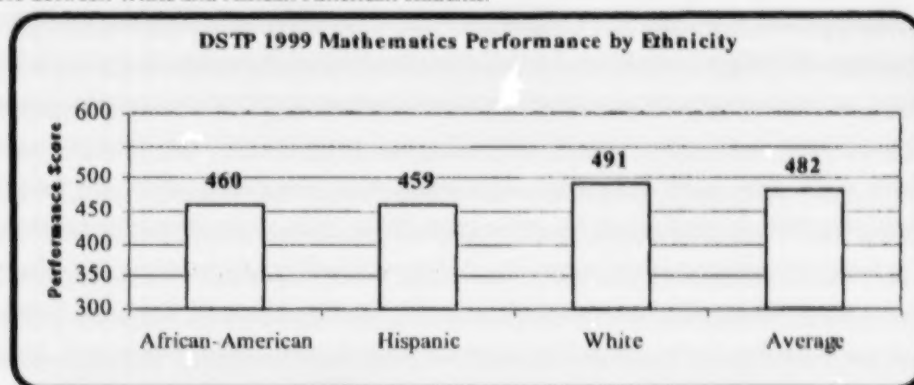


Figure 14: 8th Grade Students' Standards Based Scores on the DSTP (1999)

The simple mean performance indicates there was a performance gap across ethnicity however the percent of students meeting the benchmarks on each of the assessments is more informative than the average. **Half** of Delaware's students were below the median TIMSS-R international benchmark and **more than half** of the Delaware students did not "Meet" the DSTP performance level (See Figures 15 and 16). The Mathematics DSTP (1999) ranked 7.4% of the students as "Distinguished" yet only 5% of Delaware's students performed in the 90th Percentile or in the Top 10% of the

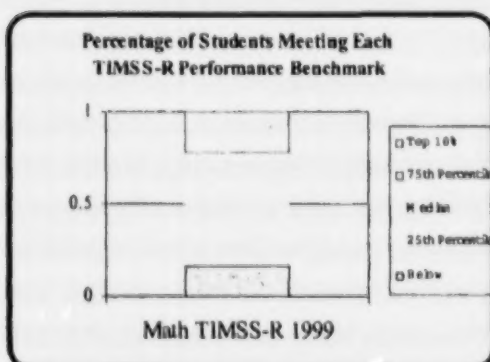


Figure 15: TIMSS-R International Benchmarks

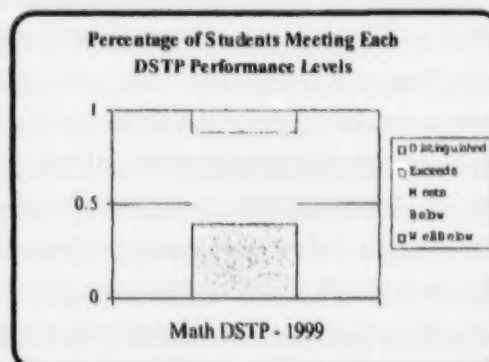


Figure 16: DSTP Performance Levels

International benchmarks. The two figures above show that it was more difficult for students to "Meet" the Delaware performance level than it was to achieve a score at the TIMSS-R Median benchmark. But it was also more likely that students would be ranked as "Distinguished" on the DSTP than perform in the Top 10% of students who participated in TIMSS-R. In other words the Mathematics DSTP classified more students as "Well Below" and "Distinguished," at the highest and lowest levels, than the International TIMSS-R Benchmarks.

The percent of students meeting each benchmark on the Mathematics DSTP are displayed by ethnicity in Figure 17. Parallel data indicating the number of students performing at each benchmark by ethnicity for the TIMSS-R has not been released at the writing of this report. However it is clear that over half the African-American students performed "Well Below" the DSTP Mathematics Performance Level and less than 1% were labeled "Distinguished" in 1999.

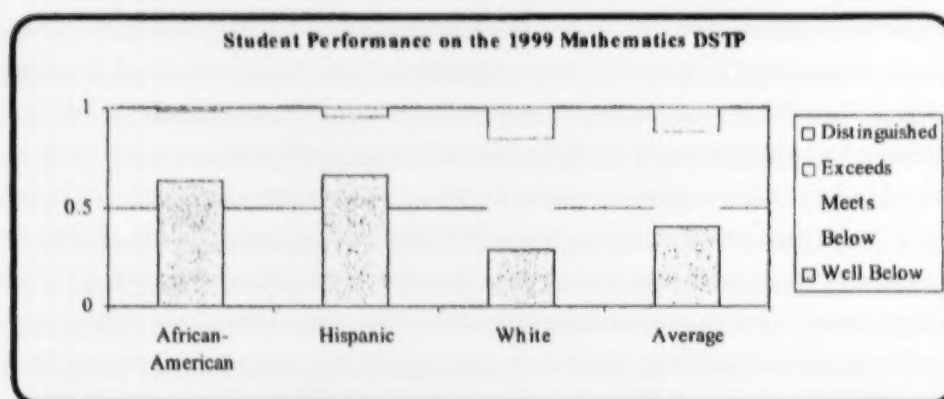


Figure 17: Ethnicity and the DSTP Performance Levels

The average performance of African American students is only 32 points lower than the White students' performance, but examining the number of students meeting each performance level indicates that twice as many African Americans are in the "Well Below" performance level compared to White students. In addition, 9.8% of White students performed at the "Distinguished" level and only 1.9% of the African Americans performed at this same level. The results are similar for the Hispanic students in Delaware.

Science

The year 2000 was the first time that Science was tested by the Delaware Student Testing Program (DSTP) at the 8th grade. Therefore the student performance data examined in science are from the 2000 administration of the DSTP. The TIMSS-R data were collected in 1999 so the comparison is not of the same students. But the purpose of this examination is to look Statewide at

the performance gap across ethnicity and it will be assumed in this report that the gap would not have varied much from 1999 to 2000. In Figure 18, students' TIMSS-R Science performance across ethnicity is displayed for the four States included in this study.

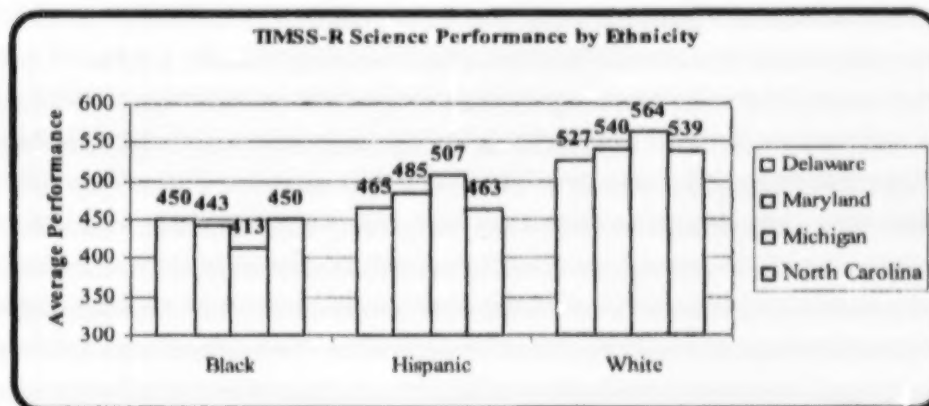


Figure 18: Average Science Performance Across Ethnic Groups.

The achievement gaps between Black and White students for each State are listed below in Table 3. Similar to the Mathematics TIMSS-R achievement gap, Delaware's White students are performing lower than their counterparts in other States but the Black students' perform similar to their counterparts making the gap between Black and White performance smaller than other States.

State	Delaware	Maryland	Michigan	North Carolina
Performance Difference	77	97	151	89
Percent Difference of 800 Points	10%	12%	19%	11%

Table 3: TIMSS-R Science Achievement Gap Across Black and White Student Performance

The student performance across ethnic groups on the Science (2000) Delaware Student Testing Program also displays a gap between the White and Non-White students. The scores available are raw scores not scaled like the TIMSS-R. But the performance gap across ethnic groups can inform the conversation. The first science DSTP figure displays the students' average raw scores across ethnicity (See Figure 19). There is a 10-point difference between the average scores between White and African-American students out of a possible 68 points.

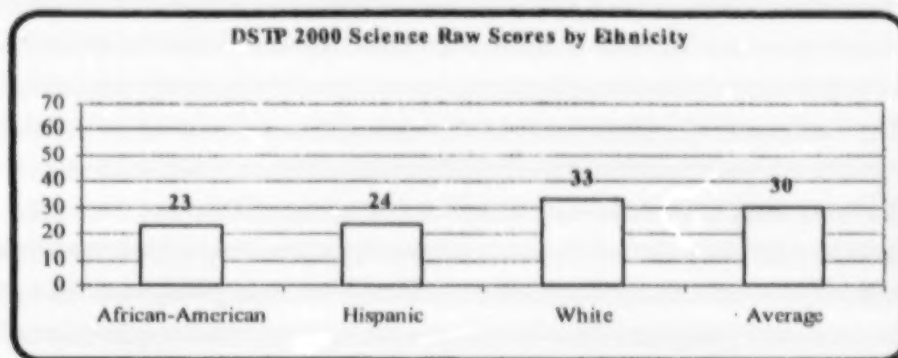


Figure 19: Science DSTP 2000 Raw Scores Across Ethnicity

The performance differences across ethnic groups are consistent (2-3 points) across the content strands: inquiry (11 possible points), physical science (19 possible points), earth science (16 possible points), and life science (22 possible points). These same four content areas were also tested on the TIMSS-R Science assessment. The TIMSS-R International Benchmarks indicated that 10% of Delaware's students performed equivalent to the Top 10% of all students tested, but similar to the Mathematics performance, 17% of the students are performing below the 25th Percentile. Parallel data are not available for the Science DSTP because 2000 was the first year of administration.

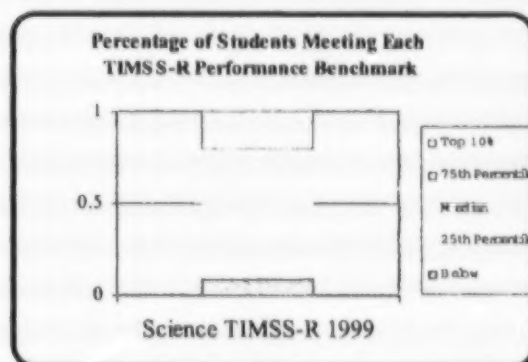


Figure 20: TIMSS-R Science Benchmarks

Summary

The comparison of the TIMSS-R and DSTP across ethnicity reveals some issues of concern.

- ☒ There is a significant difference between the Black and White students' performance on the TIMSS-R in mathematics and science.

- ☒ Delaware's White students are performing below the White students in Maryland, Michigan, and North Carolina in mathematics and science.
- ☒ Half of Delaware's students were below the median TIMSS-R Mathematics international benchmark, and more than half of Delaware's students did not "Meet" the DSTP Mathematics performance level.
- ☒ 55% of African-Americans, 55% of Hispanics, and 22% of Whites are performing "Well Below" the DSTP Mathematics performance level.
- ☒ The Mathematics DSTP classifies more students at the highest and lowest performance levels than the TIMSS-R
- ☒ White students are out performing African-American students' raw scores on the Science DSTP 33 to 23.

Questions for discussion concerning ethnicity and student performance might be:

- (1) Why are so few African-American students performing at the higher performance level on the Mathematics DSTP?
- (2) White students' raw scores are 1.5 times better than the African-American students' scores on the Science DSTP. Is this an accurate reflection of the students' understanding of science or might the items differentiate students in dissimilar ways?
- (3) The DSTP is in its early years of development. How might student performance on the TIMSS-R inform item development for the DSTP in Mathematics and Science?
- (4) How do the TIMSS-R benchmarks compare to the DSTP performance levels? Why are significantly more students performing at the "Well Below" performance level on the DSTP than below the 25th percentile on the TIMSS-R? Is this satisfactory and what does this mean for accountability?
- (5) If the performance gaps in Mathematics and Science were in the other direction with African-American students outperforming White students what might the reaction be?

(3) DELAWARE STUDENTS' LIVES & THE CLASSROOM

Student Beliefs and Educational Attitudes

3. How do Delaware students' beliefs about their education and out of class activities compare with other States and consortia?

The investigation of research question 3 begins by examining students' report of how much they like mathematics and science. The students in Delaware responded similarly to the other States and Consortia except North Carolina, which was slightly higher in the number students that reported they liked mathematics "a lot" (See Figures 21 and 22).

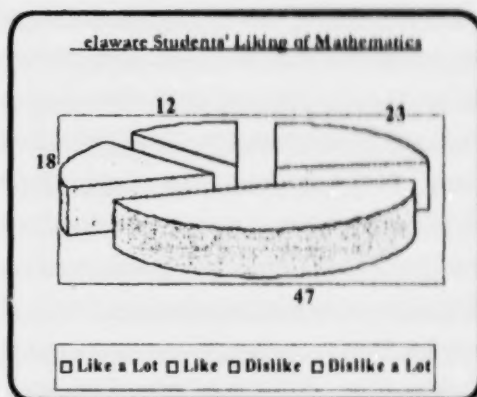


Figure 21: Delaware Students' Report

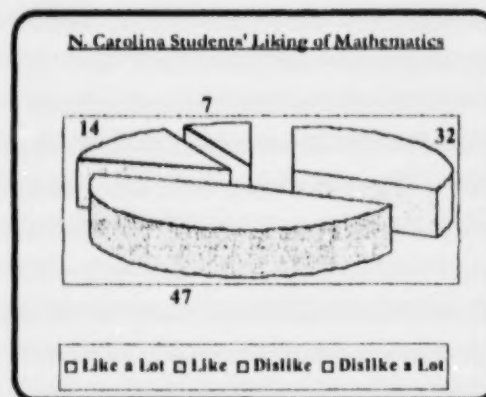


Figure 22: North Carolina Students' Report

Students' responses for science were slightly higher with 73% of Delaware students reporting they liked science or they liked it a lot, as opposed to 70% in mathematics. Again the results were similar for other States and consortia.

Next, the investigation turned to examine students' reported motivation for success in mathematics and science. Students were asked if their friends thought it was important to do well in science and in mathematics. The results for the seven States and consortia are in Figure 23. Across all States and Consortia slightly more students report that their friends think it is important to do well in mathematics than in science.

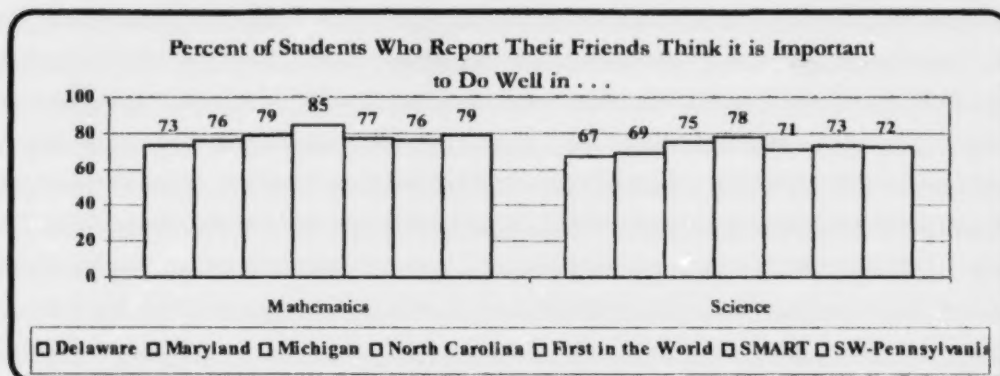


Figure 23: Percent of students reporting it is important to do well in Math & Science

Overall students think it's important to do well in mathematics and science and the following figure displays students' report of why they think they need to do well. Students in all States and Consortia included in this study view mathematics as more important to get a desired job and for admission to higher education compared to science (See Figures 24 and 25).

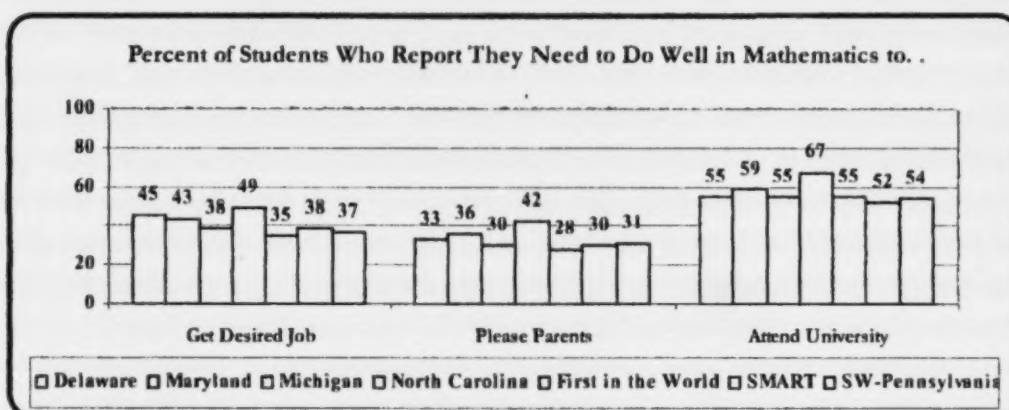


Figure 24: Students' beliefs about why they need to do well in Mathematics

However students' reported that they want to please their parents almost equally in mathematics and science. But they also view mathematics as more critical to obtaining a desired job and to attend a university. It is also interesting to notice that the students from First in the World, who performed well across both mathematics and science, report the least influence of future work, pleasing their parents, or admission to university as their motivation for learning. These students might view another less tangible reason to do well in mathematics and science.

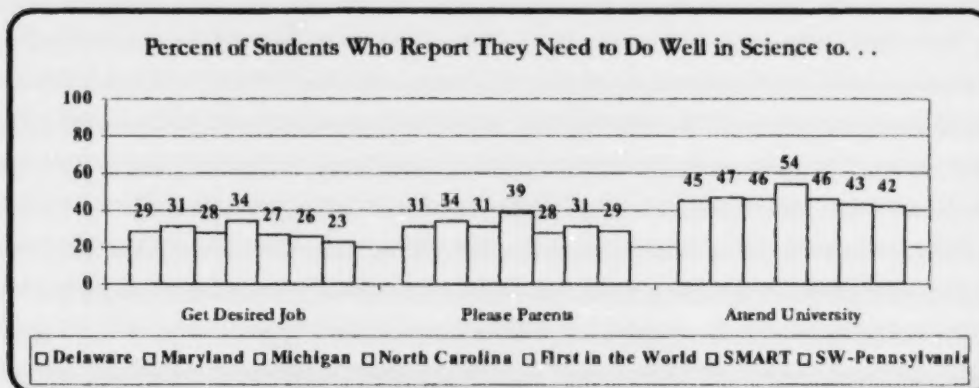


Figure 25: Students' beliefs about why they need to do well in Science.

Finally this research question required an examination of students' reported out-of-school time. Students were asked to report the number of hours they spent daily on a variety of leisure activities. These results are displayed in Figure 26. The students from the First in the World Consortium reported the **least** amount of time watching television, playing computer games, spending time with friends, doing jobs at home, and playing sports, and the **most** time reading for enjoyment compared to the other entities. The First in the World students also reported 2.3 hours of homework compared to the 1.9 hours of homework reported by Delaware students. However, there are low performing consortium, such as the Chicago Public Schools that report 2.7 hours of homework. Again, there are no simple answers for educational success. Nevertheless, there is reasonable consistency across the high performing States and consortia with a high percentage of students who reported they spend time **each** night studying **all** of the following: mathematics, science, and other subjects.

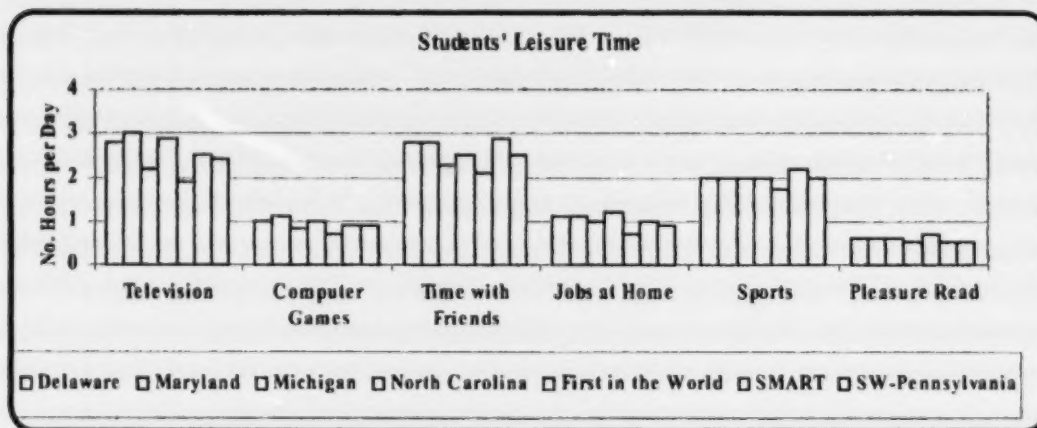


Figure 26: Number of hours students spend per day on each leisure activity.

Summary

In summary, the following can be concluded from the examination of research question 3 addressing Delaware students' beliefs about education and their out-of-school activities.

- ☒ Delaware students and those across the States and consortia investigated are fairly consistent in their likes and dislikes of mathematics and science.
- ☒ Delaware students as well as those elsewhere think it is *more* important to do well in mathematics than in science, but reported both to be fairly critical for success.
- ☒ Coupled with the previous conclusion, Delaware students think mathematics is more important than science to get a desired job and to attend university. This too is consistent with their peers in other regions.
- ☒ Delaware students spend most of their out-of-school time watching television or playing with friends. Whereas the students from First in the World spend their leisure time more evenly distributed across watching television, playing with friends, doing jobs at home, playing sports, and pleasure reading.
- ☒ Students in the high performing States and consortia reported studying mathematics, science, and other subjects each night.

Questions for discussion that influence the wider community in particular could be:

- (1) How might Delaware students be encouraged to use their out-of-school time more effectively?
- (2) What types of parental involvement and education could support more learning activities outside the classroom?
- (3) How might information be distributed to inform parents about the higher performance of students who study multiple subjects on a more regular basis?
- (4) Delaware students reported that they think it is important to do well in both mathematics and science, but how might schools develop and build upon these desires?

(4) DELAWARE STUDENTS' LIVES & THE CLASSROOM

Classroom Experience and Achievement

4. How do Delaware students describe their classroom experience?

The TIMSS-R 1999 survey for students included questions about the mathematics and science classrooms. A subset of the items and Delaware students' responses are displayed for mathematics and science. The first items presented asked students how often the teacher shows them how to do mathematics and science (See Figure 27). The overwhelming majority of students reported that Delaware teachers "almost always" show them how to do mathematics. In science, this is not the case. The students' reports were more evenly distributed.

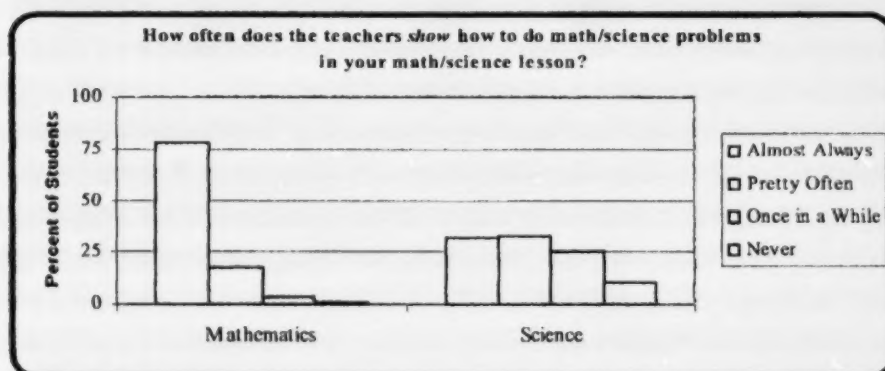


Figure 27: Students' Report of Teacher Showing them How to Do Math/Science

The next figure displays students' report of the teacher's use of rules and definitions when beginning a new topic in mathematics or science (See Figure 28). In their mathematics lessons 60% of

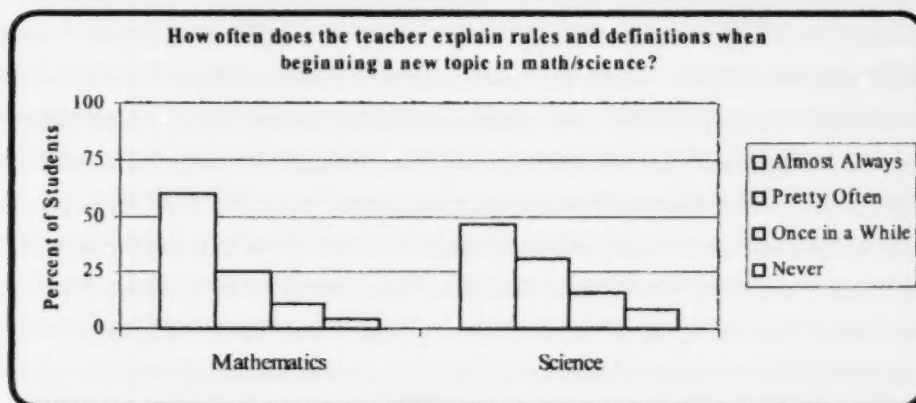


Figure 28: Students' Report of Rules & Definitions

the students reported that the teacher "almost always" begin a new topic by defining rules and definitions. 46% of the students reported that new topics in their science lessons begin with rules and definitions "almost always" (See Figure 28).

Students' report of the teacher's use of an overhead projector is displayed in Figure 29. Overhead projectors are used more frequently in Delaware's mathematics lessons than in science. A similar pattern is found in students' report of teacher's use of the board during lessons (See Figure 30).

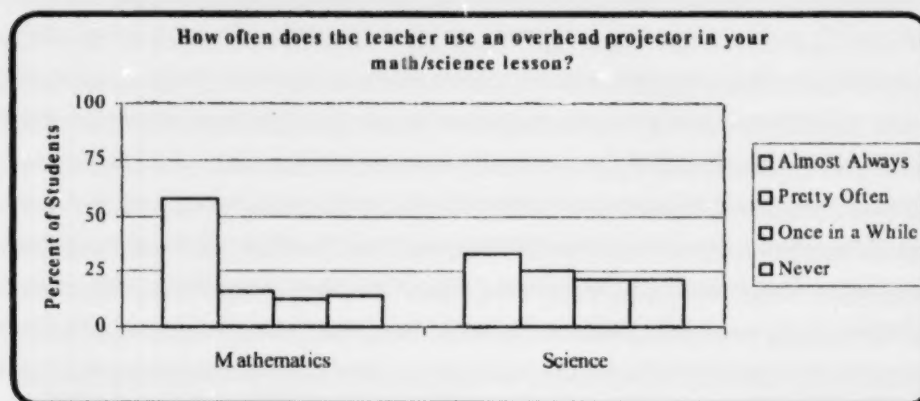


Figure 29: Students' Report of Teacher's use of the Overhead Projector

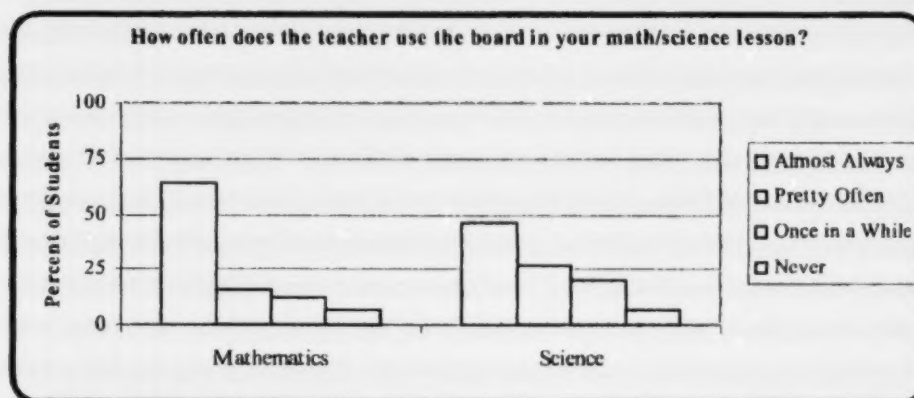


Figure 30: Students' Report of Teacher's use of the Board

As a reminder these data were collected in 1999 before the reform-minded curricula in both mathematics and science were used in the State of Delaware. Pedagogical methods in each content area might have changed over time with the implementation of new curricular materials. The next

figure shows that half of the Delaware students reported they work from worksheets or their textbooks "almost always" in their mathematics and science lessons (See Figure 31).

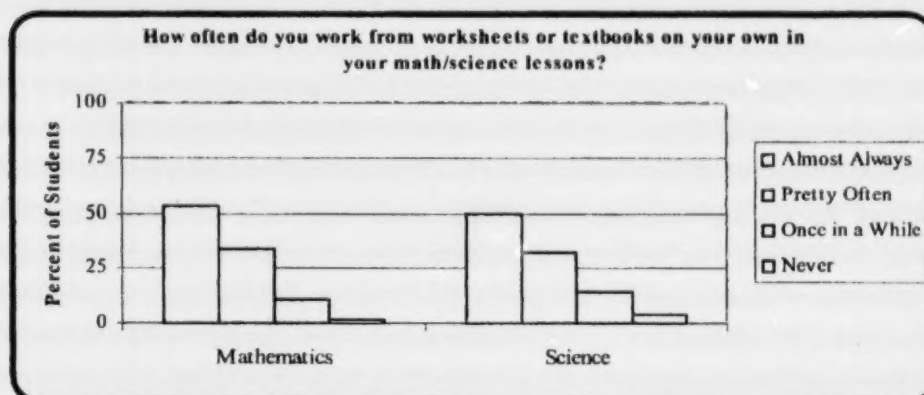


Figure 31: Students' Report of Worksheet and Textbook Usage

The majority of Delaware's students reported that they have quizzes or tests "pretty often" or "almost always" in both their mathematics and science lessons (See Figure 32).

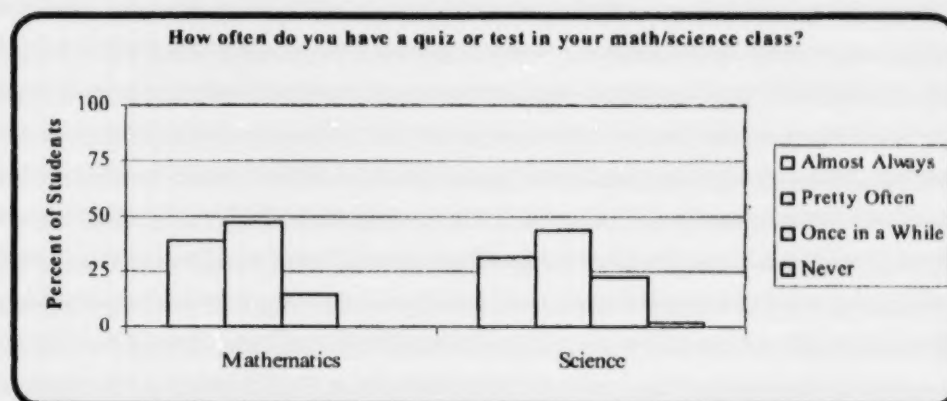


Figure 32: Students' Report of Worksheet and Textbook Usage

The last three items speak directly to reform-minded learning environments. It might be useful to collect current student feedback on these same items to get a sense of how classrooms in Delaware are changing pedagogically under the systemic reform initiatives. The first item asked students how often they worked on projects in the mathematics classrooms. 76% of the students reported that they either "never" worked on projects in their mathematics lessons or only "once in a

while." However, 60% of the students reported working on science projects "almost always" or "pretty often" (See Figure 33).

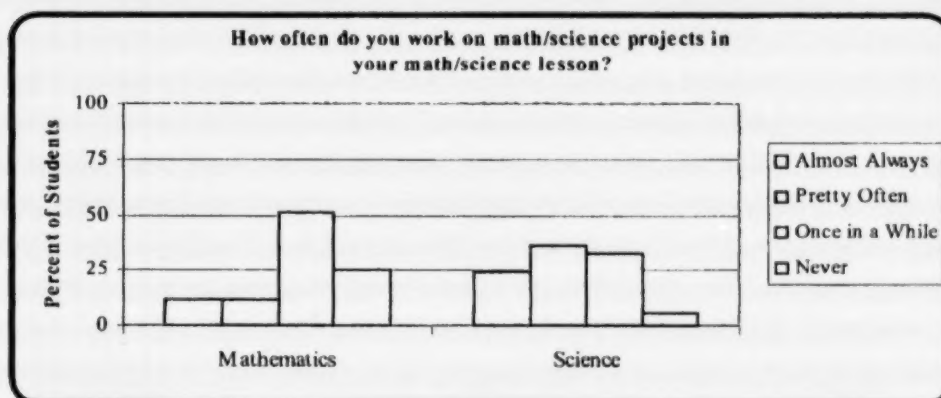


Figure 33: Students' Report of Math/Science Projects

Also aligned with the reform initiatives are collaborative student work groups. In 1999 the majority of Delaware students reported that they "never" worked in pairs or small groups or only "once in a while" during their mathematics lessons (See Figure 34). However, the majority of students reported working in pairs or groups "almost always" or "pretty often" in their science lessons.

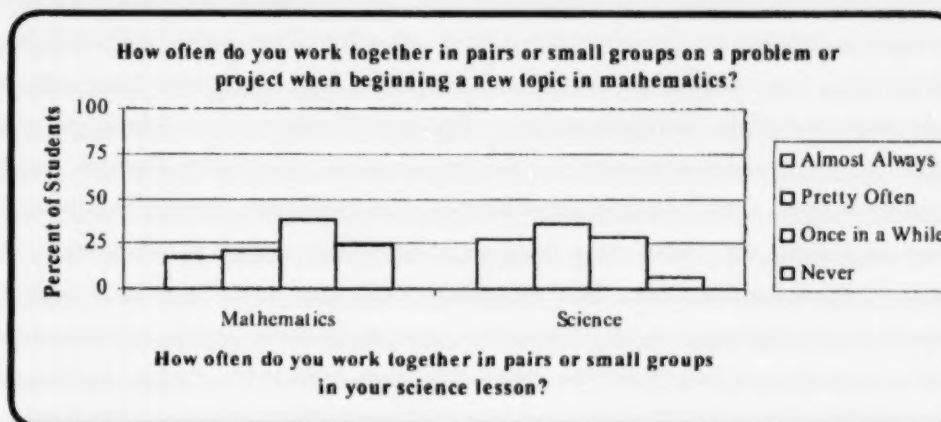


Figure 34: Students' Report of Collaboration

The final student survey item reviewed here asked students about the application of mathematics and science to their everyday life. The questions differed slightly for each content area but both addressed the issue of application and relevance to the students' everyday life (See Figure 35 for questions). About half of the students reported using mathematics word problems that were

related to their everyday life when a new topic was introduced. Just over 40% of the students reported using "things from everyday life" to solve science problems "almost always" or "pretty often."

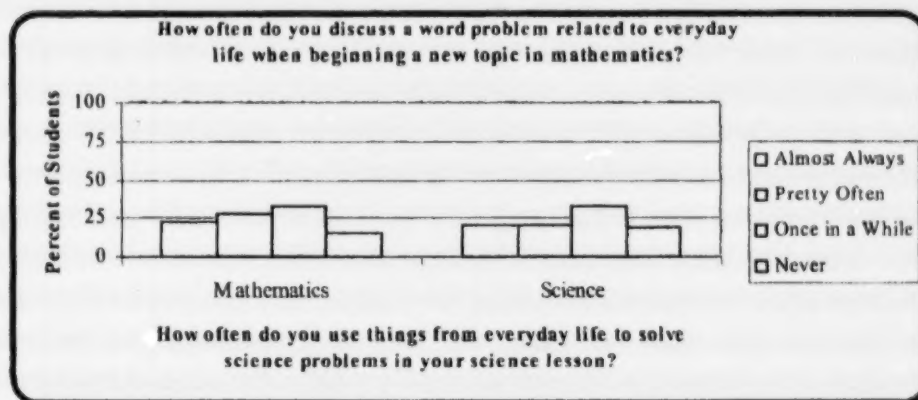


Figure 35: Students Report of Relevance of Mathematics & Science Lessons

This analysis concludes by examining students' reported classroom interruptions. Similar to the TIMSS 1995 data the frequencies of interruptions in the mathematics and science classrooms in the United States far exceed those in other high performing countries. There is little variation among the classroom interruptions within the United States but Japan is included to provide a point of comparison (See Figure 36 and 37).

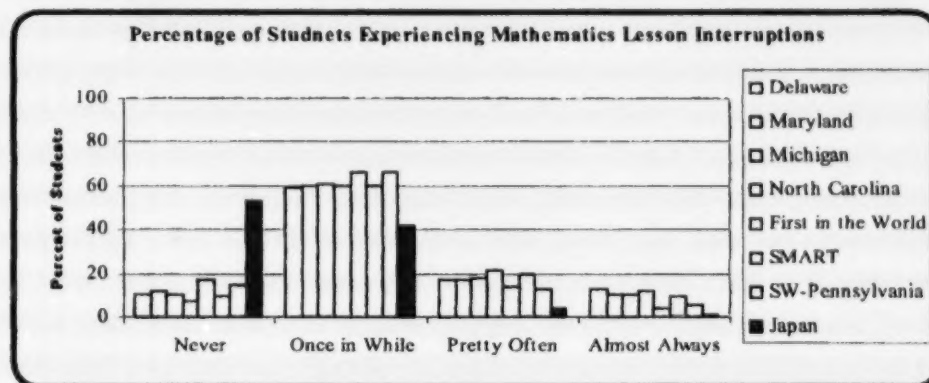


Figure 36: Students Report of Mathematics Classroom Interruptions

The students' report of interruptions is consistent across their mathematics and sciences classes. High frequencies of interruptions in the United States classrooms were confirmed by the TIMSS Video analysis and are discussed in detailed in Stigler and Hiebert's (1999) *The Teaching Gap*. Similar to levels of teachers' reported confidence, there are likely cultural norms that manifest themselves in classroom lessons and teachers' dispositions.

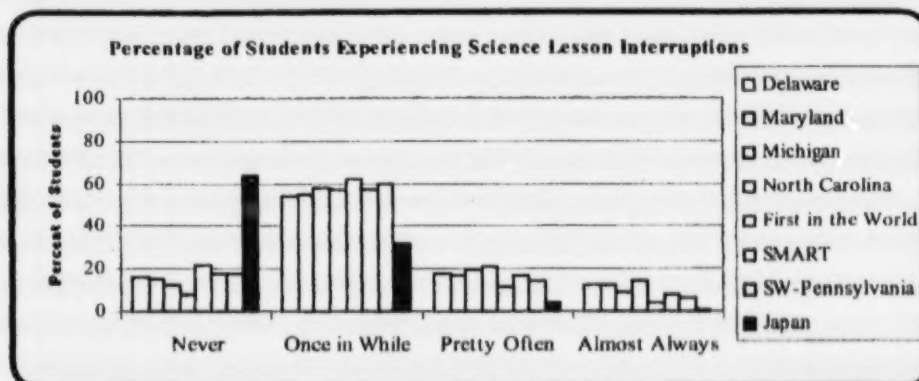


Figure 37: Students Report of Science Classroom Interruptions

Summary

In summary the investigation of these ten student survey items provides a glimpse into Delaware classrooms from the learners' perspective. The following conclusions can be made from the investigation of research question 4 and the students' report.

- ☒ The majority of students reported that their mathematics teachers show them how to do math and begin new topics by explaining rules and definitions.
- ☒ Half of Delaware students reported they used textbooks or worksheets "almost always" in both their mathematics and science lessons.
- ☒ Delaware students reported more projects and collaboration in their science lessons than in mathematics lessons.
- ☒ Students in Delaware experience frequent classroom interruptions in their mathematics and science lessons.

Some questions for discussions might include:

- (1) How might students' perceptions and reports of their classroom change with the reform-minded curricula and the systemic initiatives in Delaware?
- (2) How reliable are students' reports of classroom practice?
- (3) Could student report be a valuable source of information to inform changing classroom practice in the State?
- (4) How might a school or school district minimize classroom interruptions and maintain the integrity of the lesson?

(5) DELAWARE TEACHERS AND THEIR PRACTICE

Delaware Mathematics and Science Teachers' Background

5. How do Delaware teachers compare with other States and consortia?

The TIMSS-R data used to explore research question 5 begins with the teachers' area of study at university. The majority of Delaware students are not being taught by a mathematics teacher with either a mathematics or mathematics education major (See Figure 38). Whereas teachers who majored in Mathematics or Mathematics Education are teaching 70% of the students in the First in the World Consortium and over half of the students in the State of Michigan. The students in both of these regions significantly outperformed the international average in mathematics and Michigan students' performed better than any other TIMSS-R participating state.

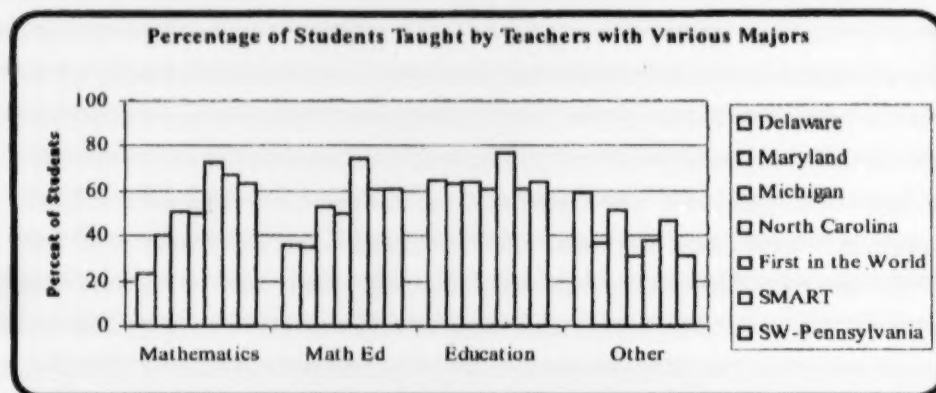


Figure 38: Mathematics Teachers' University Majors

The results are similar in science with few Delaware teachers with content area degrees teaching middle school science. Teachers who hold degrees in Biology, Chemistry, or Physics teach less than half of Delaware middle school students (See Figure 39). The SMART consortium and First in the World both have significantly more teachers with Science and Science Education majors. Delaware students are more likely to be taught by teachers with degrees *other* than mathematics, science, or education teaching their mathematics and science courses than in any other entity included in this report.

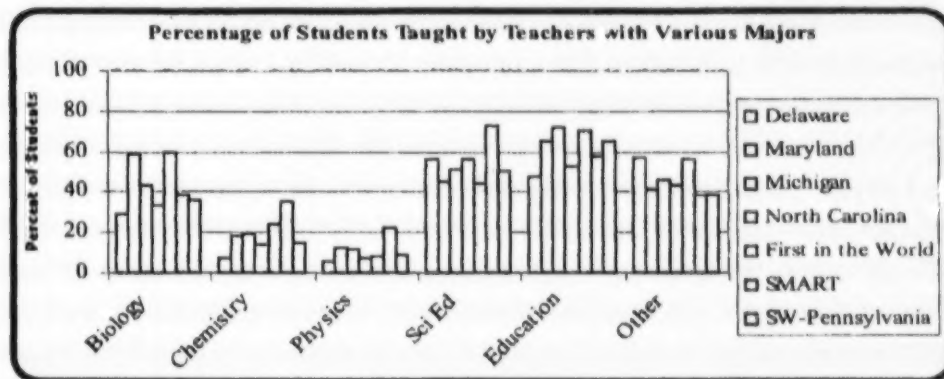


Figure 39: Science Teachers' University Majors

Next the analysis shifts to examine teachers' level of confidence in their instructional practice. Given that there are many teachers teaching out of their content area, it might be expected that Delaware teachers would be less confident than the other entities. In fact, although Delaware teacher confidence is relatively high in mathematics, it is not quite as high as the other entities (See Figure 40). The math confidence is extremely high across all of the participating States and consortia in general and when compared to the Asian countries. For example, only 8% of students in Japan are taught by teachers who report a "high" level of confidence about their preparedness to teach mathematics. All of the participating States and consortia in the United States have 75% or more of their students taught by highly confident teachers. It might be argued that the Japanese culture is more reflective and

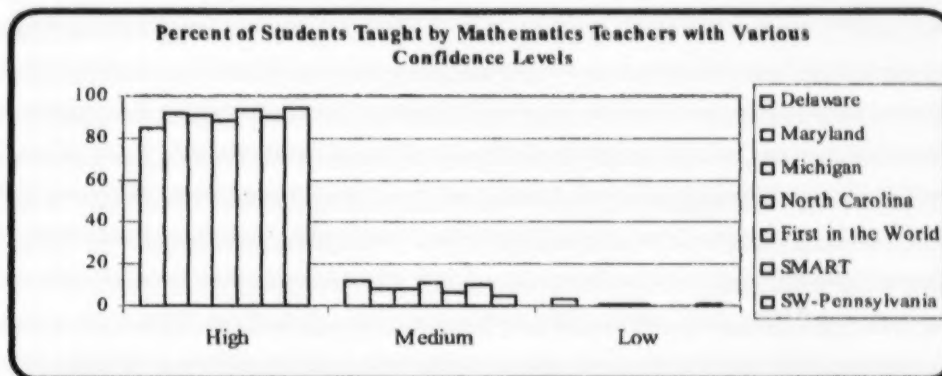


Figure 40: Mathematics Teachers' Confidence

self-evaluative. However, high levels of confidence were not reported by the science teachers in Delaware or in the United States (See Figure 41). The levels of teacher confidence are more evenly distributed across high, medium, and low. This might be a function of science teachers' various

academic majors: biology, chemistry, physics, and the diverse scientific demands of a middle school science curriculum.

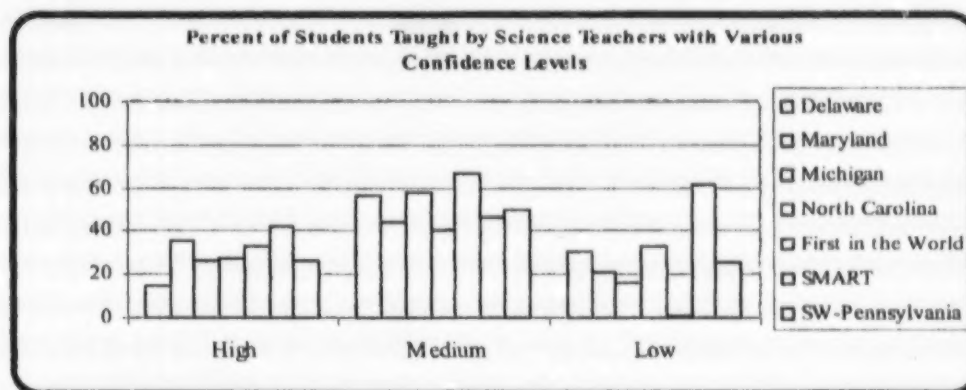


Figure 41: Science Teachers' Confidence

In addition to teachers' pre-service training, teachers' ongoing learning is critical for reform and improvement over time. Professional development and ongoing learning across States and consortia will be fully explored in a future study. But the striking difference across the selected States and consortia with respect to teacher observations could not go without mention (See Figure 42).

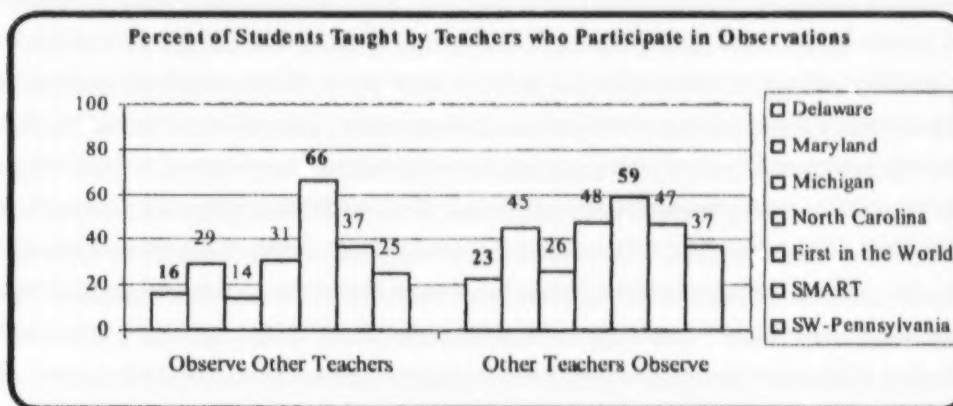


Figure 42: Teachers' Participation in Classroom Observations

Teachers, who participate in classroom observations of their peers and are also observed, teach the majority of students in the First in the World Consortium. First in the World has spent much of their effort developing a professional program for their teachers and claim their teachers to be one of their most valuable assets and instruments for change (D. Kroeze, personal communication, Sept. 2000). In

a separate study of teachers' reactions to professional development, middle school mathematics teachers reported a desire to participate in observations of their peers to help gauge their own practice regardless of their years of experience or their mathematics background. Classroom observations were the only activity the majority of teachers agreed might be a useful method to help them understand their students' thinking (Cwikla, 2001).

Summary

In summary, the following can be concluded from the examination of research question 5 addressing Delaware teachers and their background.

- ☒ The majority of Delaware students are not taught mathematics and science by teachers who have majored in mathematics, science, or math/science education and this is different from the other entities included in this report.
- ☒ Mathematics teachers who report a "high" level of confidence in their instructional practice teach the majority of Delaware students and this is consistent across the United States.
- ☒ Science teachers who report a "medium" level of confidence in their instructional practice teach the majority of Delaware students and this too is fairly consistent across the other States and Consortia.
- ☒ Teachers in the First in the World Consortium participate in classroom observations and are observed by their peers more frequently than other entities.

Some questions for discussions might include:

- (1) How can middle school mathematics and science teachers be best supported in Delaware to accommodate their diverse university backgrounds?
- (2) Teacher confidence might be an advantage but it could also be an obstacle in the context of reform. How can professional developers support continued learning and development with a confident population?
- (3) Again there is no one single solution that is guaranteed to enhance learning environments, but First in the World supports classroom observations. Is this an activity Delaware teachers would find helpful? How might such a professional activity be supported during the school day?

(6) DELAWARE TEACHERS AND THEIR PRACTICE

Classroom Practice

6. How do teachers and students describe what goes on in their classroom?

Teachers and learners might have different perceptions and descriptions of classroom practice. This could be the result of misconceptions by either party, miscommunications of learning goals, or a variety of factors. Inconsistencies within a learning environment should be addressed so that students' educational experiences are more productive. This research question will address only a few activities that were assessed on *both* the teacher and student surveys. The purpose is not to critique Delaware students or teachers by using one report against the other. The point is to better understand classroom interactions and how the teacher and the learners perceive the classroom environment.

The students were asked to rate each activity as occurring "almost always," "pretty often," "once in a while," or "never." The teachers were asked to provide a percentage of class time spent on each activity. The different scales do not provide for a seamless comparison of the teachers' and students' responses but each does provide contextual information about the classroom practice and various perceptions.

The students' report of various mathematics classroom activities is summarized in Table 4 below. Almost all the Delaware *students* reported that the teacher showed them how to do mathematics and used the board "almost always" or "pretty often." The *teachers* reported that they lecture 21% of class time and re-teach and clarify 10% of the time (See Table 5).

Mathematics Classroom Activity	Percentage of STUDENTS who reported each activity occurs "almost always" or "pretty often" in their mathematics lesson.
Teacher shows us how to do mathematics	95%
Teacher uses the board	80%
We work from worksheets or textbooks on our own	87%
Homework Review	85%
Tests & Quizzes	86%
Working in Pairs or Small Groups	39%
Mathematics Projects	24%

Table 4: Students' Report of Mathematics Classroom Activities

Delaware students also reported that they work individually on mathematics worksheets or from their textbook frequently but the teachers reported using only 13% of class time for independent student practice.

Mathematics Classroom Activity	TEACHERS' report of the percentage of class spent time spent on each activity in a month.
Teacher-Guided Student Practice	22%
Lecture Style Presentation by Teacher	21%
Student Independent Practice	13%
Homework Review	13%
Tests & Quizzes	10%
Re-teaching and Clarification of Content/Procedures	10%
Administrative Tasks	5%

Table 5: Teachers' Report of Classroom Activities

There also seems to be a difference in the report of the frequency of tests and quizzes, with mathematics teachers reporting only 10% of class time devoted to tests and quizzes and 86% of the students reporting they occur "almost always" or "pretty often." The numbers are also similar for teacher and student reports of time spent on homework review.

Next we turn to the teacher and student reports of their science classrooms (See Table 6).

Science Classroom Activity	Percentage of STUDENTS who reported each activity occurs "almost always" or "pretty often" in their science lesson.
Teacher shows us how to do science	64%
Teacher uses the board	71%
We work from worksheets or textbooks on our own	81%
Homework Review	61%
Tests & Quizzes	77%
Working in Pairs or Small Groups	63%
Science Projects	59%

Table 6: Students' Report of Science Classroom Activities

The majority of Delaware students reported that the teacher "shows" them how to do science and uses the board "almost always" or "pretty often." Similar to the mathematics teachers, the science teachers report 21% of class time spent lecturing. The science teachers reported 21% of the time was spent either demonstrating experiments or assigning the students to conduct experiments. 59% of the students reported that they conducted science projects "almost always" or "pretty often."

Science Classroom Activity	TEACHERS' report of the percentage of class spent time spent on each activity in a month.
Teacher-Guided Student Practice	13%
Lecture Style Presentation by Teacher	21%
Student Independent Practice	11%
Homework Review	9%
Tests & Quizzes	8%
Re-teaching and Clarification of Content/Procedures	9%
Administrative Tasks	5%
Teacher Demonstrations of Experiments	8%
Students Conducting Experiments	13%

Table 7: Teachers' Report of Science Classroom Activities

Summary

In summary it is clear that the students and teachers have different perceptions about the use of classroom time. It is not clear if one of the reports is more accurate than the other and the scales used on the TIMSS-R makes this comparison difficult. However, the following can be concluded:

- ☒ The majority of Delaware students reported that in both their mathematics and science classrooms the teacher "almost always" or "pretty often" showed them how to do math or science.
- ☒ Over 80% of the students reported that they "almost always" or "pretty often" work from worksheets or their textbooks in both their mathematics and science lessons.
- ☒ The science teachers reported using 21% of class time to either demonstrate experiments or assign the students to conduct experiments.

A few questions for discussion about the classroom learning environment might be:

- (1) How might students' classroom experiences change in mathematics and science with the reform-curricula?
- (2) How accurate are teacher and student reports of their classroom methods?
- (3) How would a teacher define "teacher-guided student practice" and how might this look different in 2001 compared to 1999 in the context of the reform?

CONCLUSION

This study has addressed three major areas of interest (1) Delaware students' performance on the TIMSS-R and the DSTP, (2) students' lives and their classroom experience, and (3) Delaware mathematics and science teachers and their classroom practice. The major findings from the six research questions are as follows:

- (1) Students in other States consistently outperform Delaware students across content strands and items in both mathematics and science.
- (2) There is a significant difference between the African-American and White students' performance on the TIMSS-R and the DSTP in mathematics and science.
- (3) Half of Delaware's students were below the median TIMSS-R Mathematics international benchmark, and more than half of Delaware's students did not "Meet" the DSTP Mathematics performance level.
- (4) Delaware students spend most of their out-of-school time watching television or playing with friends. Whereas the students from First in the World spend their leisure time more evenly distributed across watching television, playing with friends, doing jobs at home, playing sports, and pleasure reading.
- (5) Students in Delaware reported frequent classroom interruptions in their mathematics and science lessons.
- (6) The majority of Delaware students are not taught mathematics and science by teachers who have majored in mathematics, science, or math/science education and this is different from the other entities included in this report.
- (7) Teachers in the First in the World Consortium participate in classroom observations and are observed by their peers more frequently than other entities.
- (8) The majority of Delaware students reported that in both their mathematics and science classrooms the teacher "almost always" or "pretty often" showed them how to do math or science.

The data still leave much to be explored and require time to investigate. Some difficult questions have emerged from the data but it is hoped that this report will inform critical discussions about the current educational system in the State of Delaware and data-driven decision making.

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